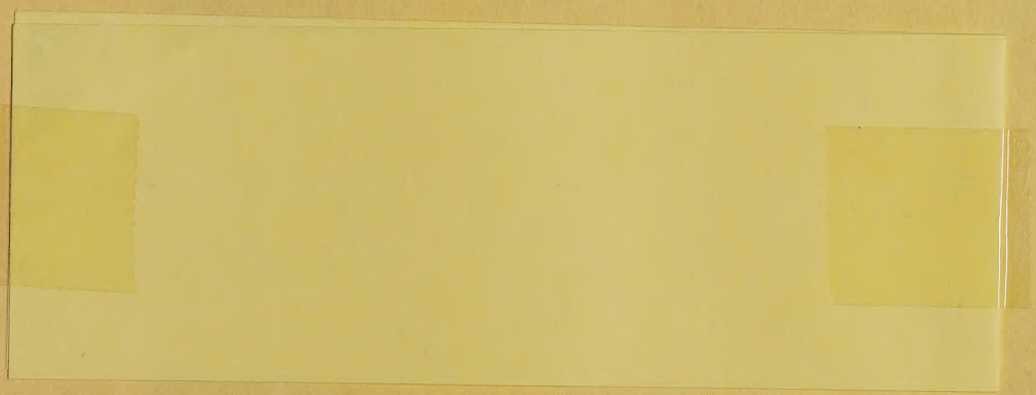
ELECTRONIC NAVIGATION INDUSTRIES, INC.

OPERATING AND SERVICE INSTRUCTIONS
MODEL 320L
BROADBAND RF POWER AMPLIFIER



MP MASTER
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ELECTRONIC NAVIGATION INDUSTRIES INCORPORATED
3000 WINTON ROAD SOUTH • ROCHESTER, NEW YORK 14623 • (716) 473-6900

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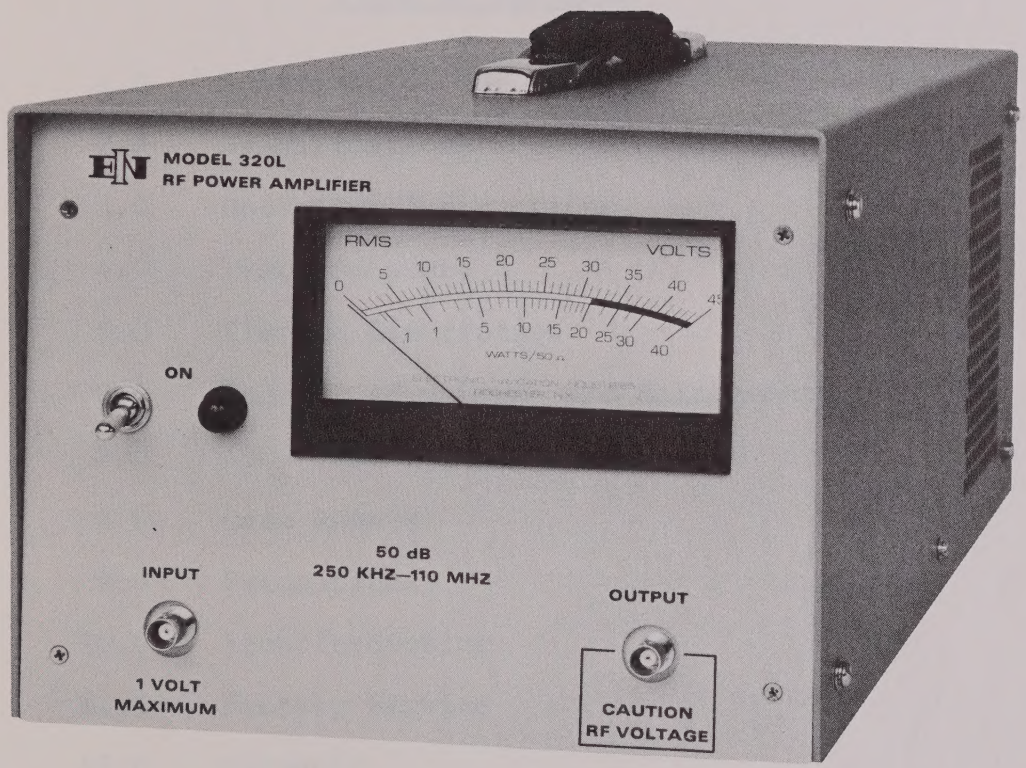

MODEL 320L
BROADBAND RF POWER AMPLIFIER

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1.0 INTRODUCTION

The Model 320L is a broadband solid state power amplifier covering the frequency range of 250 KHz to 110 MHz.

Over 20 watts of RF power can be produced at the output, with low harmonic and intermodulation distortion. A highly linear Class A design, the Model 320L will amplify inputs of AM, FM, SSB, pulse and other complex modulation, with minimum distortion. The 50 dB gain of the unit permits it to be driven to its full power output by any signal or sweep generator capable of supplying this signal.

The Model 320L operates over its entire bandwidth without tuning or other adjustments. It is capable of supplying useful power output up to 150 MHz, at reduced gain.

The unit is unconditionally stable and will not oscillate for any possible combination of source and load impedances. It is protected against failure due to output load mismatch and/or overdrive. The Model 320L will withstand a 20 dB overdrive (input signal of 1 volt RMS) for all output load conditions including both short and open circuits.

Output RF voltage level, as well as power output into 50 ohms, is monitored by a front panel meter. An integral power supply permits operation directly from the AC line.

2.0 SPECIFICATIONS

Frequency Coverage:	250 KHz to 110 MHz without tuning.
Maximum Power Output:	20 watts CW and PEP (Peak Envelope Power) at rated distortion; higher power output at increased distortion.

Input Signals:	Unit will accept CW, AM, FM, SSB, Wideband Sweep and other complex modulation, limited only by their bandwidth and peak input level.
Gain:	50 dB nominal.
Gain Variation:	Less than ± 1 dB over the entire frequency range at power outputs below 4 watts. Less than ± 1.5 dB for power outputs between 4 and 20 watts.
Total Harmonic Distortion:	Less than 6% Total Harmonic Distortion at maximum power output, lower at reduced power output.
2nd Order Distortion:	More than 30 dB down at full power output (typical).
3rd Order Intermodulation Distortion:	More than 30 dB down (typical) from 0.25 - 40 MHz; more than 25 dB down (typical) from 40 - 110 MHz at full power output.
Typical 3rd Order Inter-Modulation Intercept Point:	+52 dBM.
Input - Output Impedance:	50 ohms.
Input VSWR:	Less than 1.6 (typical).
Output VSWR:	Less than 2.0
Noise Figure:	Less than 12 dB
Stability:	Unconditionally stable; unit will not oscillate for any condition of load and source impedances.
Protection:	Unit will withstand a +20 dB overdrive (input signal of 1 volt RMS) for all output load conditions, including short and open circuit loads.

Output Metering:	Average reading voltmeter, calibrated in RMS volts for a sine wave, with an accuracy of ± 3% of full scale (0 - 45 volts and 0 - 40 watts)
Power Requirements:	105 - 125 VAC, 50 to 60 cps or 210 - 250 VAC (Optional)
Operating Temperature:	0^{o} to $+50^{o}$ C.
Size:	6 x 8 1/2 x 15 inches.
Weight:	32 lbs.
Input and Output Connectors:	BNC

3.0 OPERATING INSTRUCTIONS

The Model 320L is easy to connect and use. The input and output are connected via the front panel BNC connectors to the signal source and load respectively.

The input signal should be increased gradually while observing the output voltage on the output RF voltmeter. Input signal voltage should never be allowed to exceed 1 volt (RMS) or 1.4 volts (peak).

When the Model 320L is connected to a 50 ohm load, the CW power output of the unit may be read directly from the meter scale. The red portion of the meter indicates that the amplifier is no longer operating in its most linear region and increased distortion may result. This occurs at 20 watts (PEP or CW) of RF output power into 50 ohms (44.5 volts peak).

When the amplifier is connected to an arbitrary or unknown load impedance, the following procedure will insure low distortion power output.

(1) Disconnect the output load cable from the output BNC connector of the Model 320L.

(2) If the CW output voltage is less than the red line value (31.5 volts RMS), the unit is operating at low distortion regardless of the load impedance.

(3) Reconnect the output of the amplifier to the load.

If the output of the amplifier is monitored by a high frequency oscilloscope (or spectrum analyzer), the input signal may be increased until the point of maximum undistorted power output is observed.

4.0 TEST PROCEDURE

To determine proper operation of the Model 320L, the following test procedure should be used:

(1) Connect a sweep generator capable of sweeping the frequency range of 1 to 110 MHz to the input BNC connector.

(2) Adjust the output level of the sweep generator so that a 50 ohm video detector connected at the output will not be damaged by excessive power.

(3) Connect the 50 ohm video detector to the output of the Model 320L.

(4) Observe the gain versus frequency ripple on an oscilloscope calibrated in decibels.

(5) The gain variation over the frequency range should be less than $\pm$ 1 dB.

(6) Connect a calorimetric power meter (e.g., HP 434A) through a short length of 50 ohm cable and a 10 dB attenuator (Narda 766-10 or equivalent) to the output BNC connector.

(7) Adjust the input CW signal level (at any frequency between 0.25 and 110 MHz) until the front panel meter reads 20 watts. Compare this with the reading

of the calorimetric wattmeter. They should be within ± 2 watts.

(8) Observe the output signal on a spectrum analyzer connected to the output through at least 40 dB of external attenuation. The total harmonic distortion contributed by the amplifier should be less than 6% (voltage) of the fundamental.

5.0 CIRCUIT DESCRIPTION

A block diagram of the entire 320L is shown in Figure 1.

Input signal from the front panel BNC is fed to the preamplifier module (Item 1, Figure 2). The preamplifier has eight equal amplitude and phase outputs. These are fed via RG 174 coaxial cable to the inputs of the eight power amplifier modules. Each preamplifier channel has an overall gain of 21 dB and a maximum power output of 100 milliwatts into 50 ohms. A factory adjusted peaking control (Item 2) compensates for the high frequency gain roll-off of the power amplifier modules.

The Model 320L achieves its high power output by combining the outputs of sixteen separate power amplifier stages. Hybrid combiners couple the individual stage outputs to the main amplifier output. The stages are highly isolated by these combiners and between stage interaction is negligible. Eight power amplifier modules, consisting of two output stages each, are mounted symmetrically on the 320 heat sink shown in Figure 2, Item 3.

Each of the eight power amplifier modules has a 50 ohm input and output impedance. The inputs (UG 1619) are mounted at the rear of the modules and the outputs are located at the forward end. The modules are individually adjusted for a maximum power of 3 watts output and have a gain of approximately 20 dB at the low end of the frequency range, decreasing to 16 dB at 110 MHz.

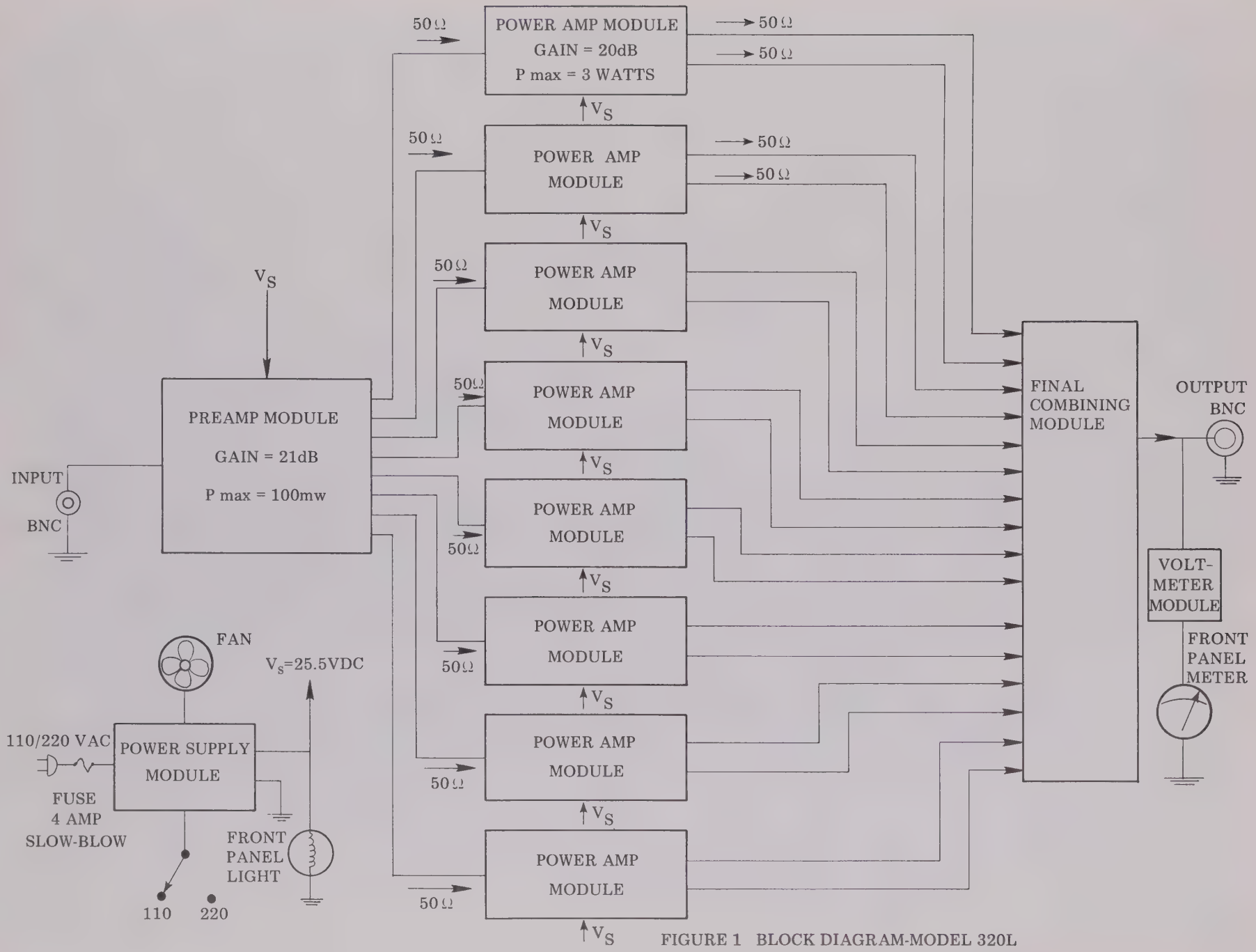

FIGURE 1 BLOCK DIAGRAM-MODEL 320L

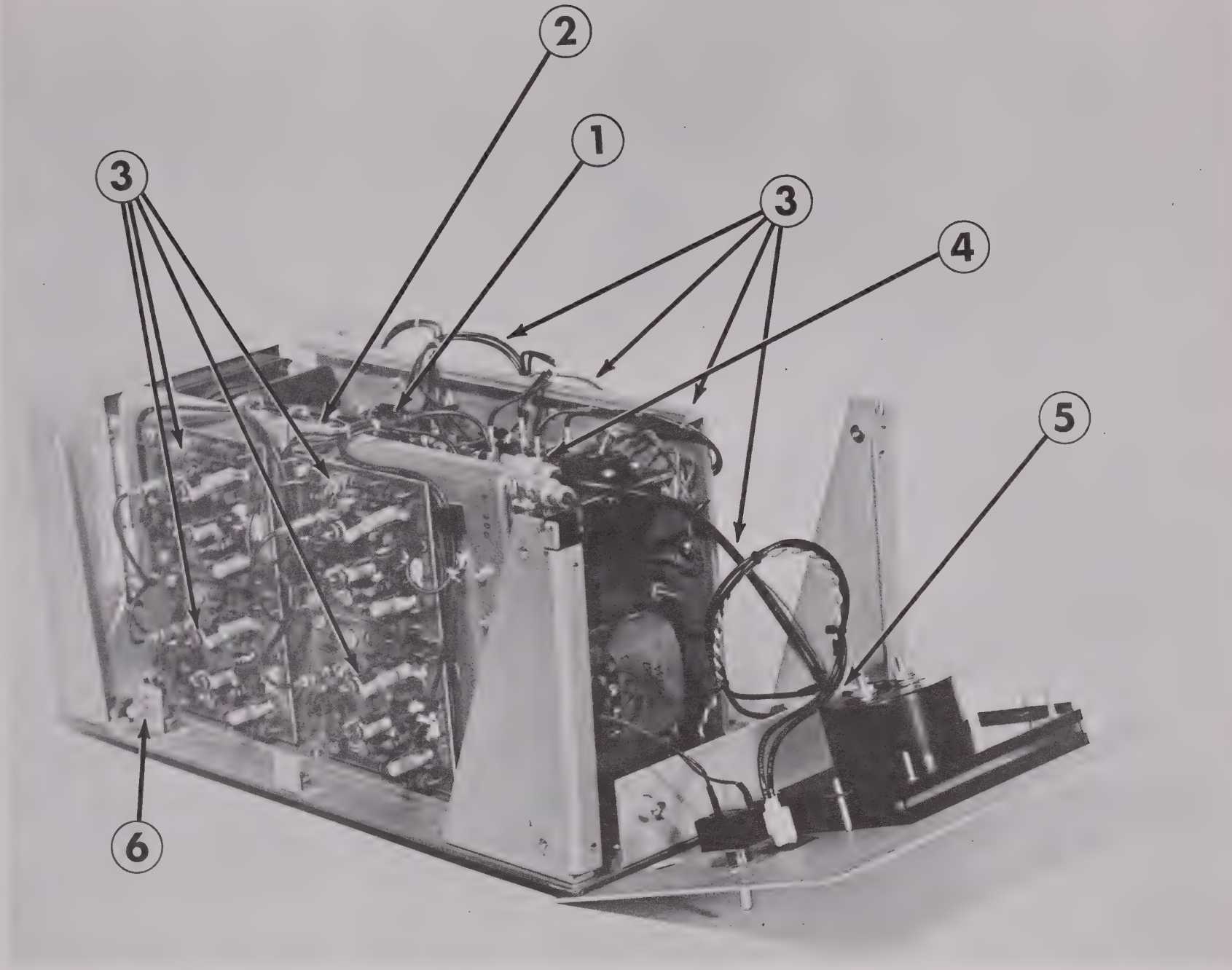

FIGURE 2 INSIDE VIEW-MODEL 320L

The outputs of the power amplifiers are combined in the final combining module (Item 4). This hybrid combiner covers the entire frequency range with a maximum of 0.7 dB insertion loss. The main output of the combining module is fed via coaxial cable to the front panel output BNC connector.

The voltmeter module is connected to the output BNC connector. It samples the RF voltage present at that point and produces a DC voltage proportional to its average value. This DC output is fed to the front panel meter, which is calibrated in RMS volts for a sine wave. The bottom scale of the meter is calibrated in watts into 50 ohms for a sine wave. Absolute calibration of the voltmeter is accomplished by a variable control mounted on the module (Item 5).

The entire unit is powered by a regulated power supply capable of supplying 25.5 volts (approximately) at a current of eight amperes. The power supply circuit module is mounted directly below the inverted "U" in the path of the forced air cooling. DC voltage adjustment is accomplished by a variable control mounted on the left side (Item 6). A short circuit protection control is set at the factory to protect against damage due to inadvertent (short time) output short circuits. The DC output current is fed in series with a thermostat mounted on the front of the amplifier heat sink. Should the fan fail or obstruction in the filter screen prevent adequate cooling, the thermostat will open and prevent damage to the unit.

An optional 110 - 220 v switch mounted on the rear panel enables the 320L to be operated from either line voltage.

6.0 REGULAR ADJUSTMENT AND MAINTENANCE

There are no periodic electrical adjustments required to maintain the amplifier gain and power output characteristics.

Periodic cleaning and lubrication of the fan filter

should be done every six months under ordinary service conditions. To remove the fan filter, insert a screw driver in the two top slots and gently pry it off. To clean the filter, it should be soaked in an industrial cleaner solution such as "Toluene" for two minutes. After drying thoroughly, lubricate it with a few drops of number 10 oil. To re-insert the filter, push in both sides, until the unit "clicks" into its holder.

7.0 110 - 220 VOLT OPERATION

The optional power supply switch is located at the rear of the back panel through a snap plug. The 110 volt connection is the left position of the switch and is clearly labeled on the back panel. For 220 volt (foreign voltage) operation, the switch should be in the right hand position. Under no circumstances should this switch be thrown while power is connected. Before the Model 320L is connected to a 220 volt line, check the position of this switch. Extensive damage will result to the unit if it is placed in the wrong position.

If there is no voltage label (110-220) on the back panel, the Model 320L is permanently wired for 110 volt AC operation.

8.0 Case Removal

The first step in removing the cover is to disassemble the front panel by removing its four retaining screws. Access is provided through the front panel opening to the RF voltmeter calibration controls. (see Figure 2)

The bezel retaining nuts located internally on each side on the upper inside corner on the case shall be loosened next.

Finally, remove all the screws located on both sides of the cover and slide the cover backwards approximately one inch until it clears the front bezel and lift off. To reassemble, simply reverse the process. When repacing the cover, care should be taken that the case does not come in contact with the internal amplifier cabling.

9.0 PRECAUTIONS

(1) The Model 320L output is at DC ground potential through the final combining transformer. Therefore, the output should not be directly connected to a load on which there is a DC potential. If the output load has a DC potential, insert a series capacitor with the appropriate voltage breakdown rating (.1 mfd is the recommended value) between the load and the output cable.

(2) The input and output of the Model 320L should not be connected together. This will cause oscillation and may damage the input preamplifier.

(3) The 320L should not remain connected to an antenna when the unit is not in use. If thunderstorms are likely, it would be prudent to earth ground the unit's case.

(4) When the input signal voltage of a drive source is unknown, insert an attenuator between it and the Model 320L input.

10.0 TROUBLESHOOTING

If the Model 320L should fail to operate, and the panel light does not glow, check the condition of the fuse at the rear of the unit (4 amp slow-blow).

If the unit cycles on and off over a period of time, check the conditions of the fan filter (see maintenance instructions).

Should the Model 320L fail to operate properly, each individual amplifier module may be tested for power output and frequency response in accordance with Figure 1 and following the test procedures of Section 4.

The Model 320L circuit modules should be serviced only by the factory or its authorized facility. However, ENI will supply pre-aligned and calibrated module boards as replacement items.

DO NOT ATTEMPT to probe the circuit modules while they are mounted in the amplifier case, as extensive damage may result.

11.0 FACTORY SERVICE

When factory service is required, the following steps should be taken:

(1) Notify ENI, giving full details of the difficulty. Include the instrument's serial number.

(2) Upon receipt of shipping instructions, forward the instrument, transportation prepaid, to the factory or to the authorized repair station indicated on the instructions.

If requested, an estimate of the charge will be made before the work begins, provided the instrument is not covered by the warranty.

W A R R A N T Y

Electronic Navigation Industries, Inc. warrants each instrument to be free from defects in material and workmanship. Our liability under this warranty is limited to servicing and replacing any defective parts for a period of one (1) year after delivery to the original purchaser.

When warranty service is required, the instrument must be returned transportation charges prepaid to the factory or our authorized service facility. If in our opinion, the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at cost. In this case, an estimate will be submitted before the work is started.

There are no other warranties expressed or implied, including any warranty of merchantibility or fitness. Seller shall not be responsible for any incidental or consequential damages arising from any breach of warranty.

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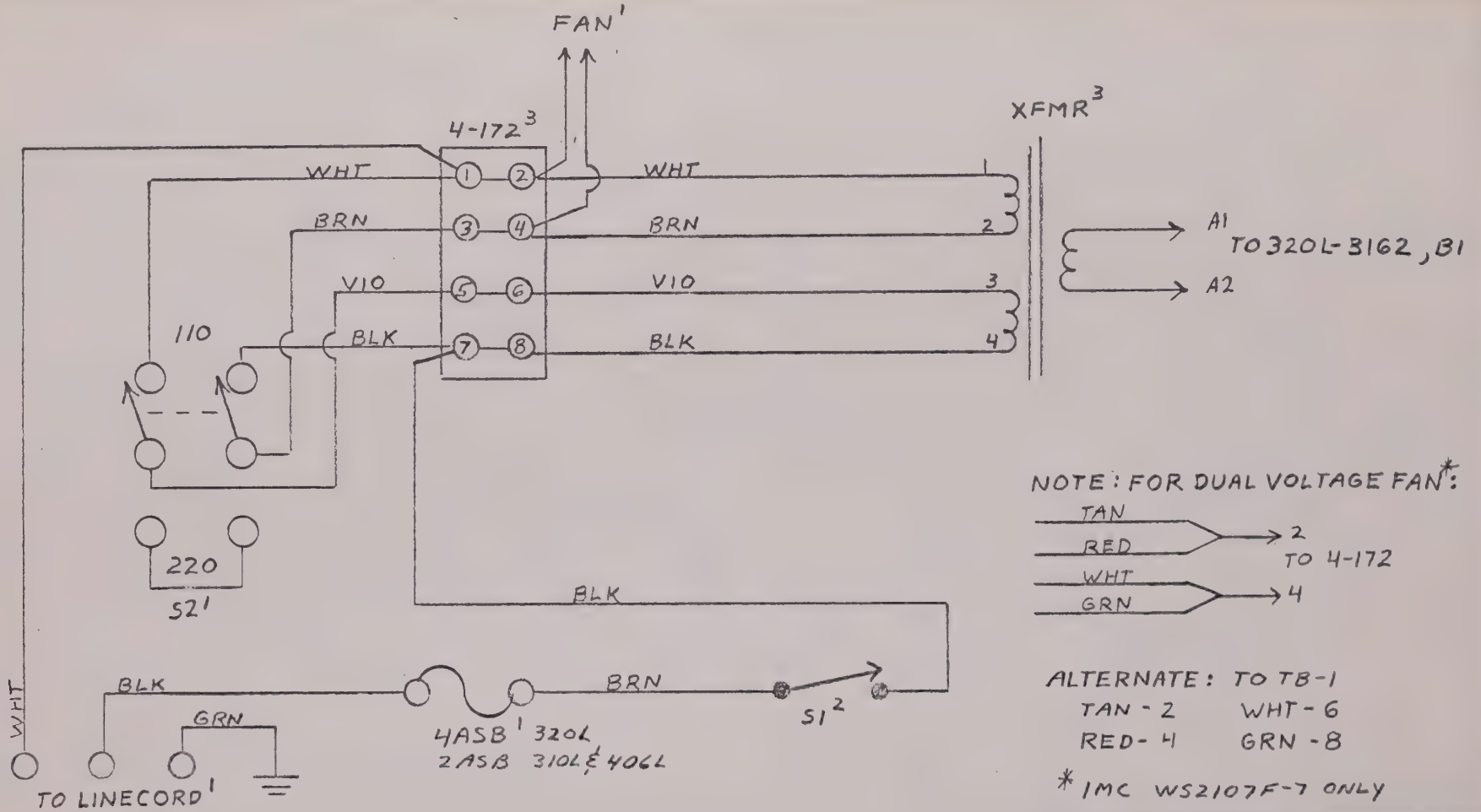
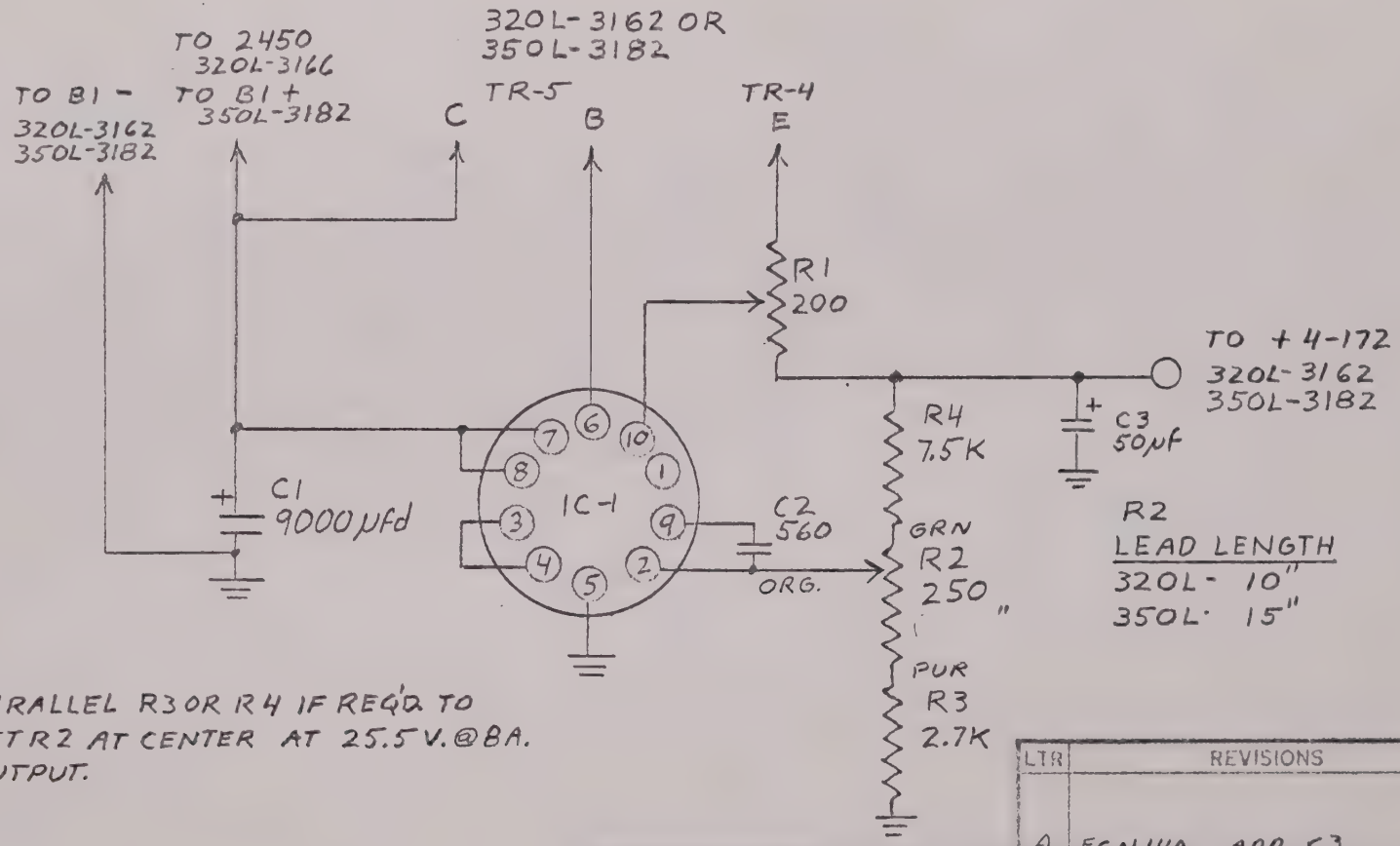


COMPONENT LOCATION	
1	320L-3163
2	320L-3164
3	320L-3161

LTR	REVISIONS	DATE
A	ECN 133	3/73

TOLERANCE EXCEPT AS NOTED	ELECTRONIC NAVIGATION INDUSTRIES, INC.		
DECIMAL	MODEL NO. 320L	SCALE —	DRAWN BY JC APPROVED BY
FRACTIONAL	DESCRIPTION POWER DIST. LAYOUT		
ANGULAR	DATE DEC. 72	DRAWING NUMBER 320L-2161	



NOTE: 1 PARALLEL R3 OR R4 IF REQ'D TO SET R2 AT CENTER AT 25.5 V. @ 8A. OUTPUT.

LTR	REVISIONS	DATE
A	ECN 140 ADD C3	4-73

TOLERANCE EXCEPT AS NOTED	ELECTRONIC NAVIGATION INDUSTRIES, INC.		
DECIMAL	MODEL NO. 320L	SCALE –	DRAWN BY JC
			APPROVED BY
FRACTIONAL	DESCRIPTION A13 POWER SUPPLY		
ANGULAR	DATE DEC. 72	DRAWING NUMBER 320L-4163	

LTR	REVISIONS	DATE
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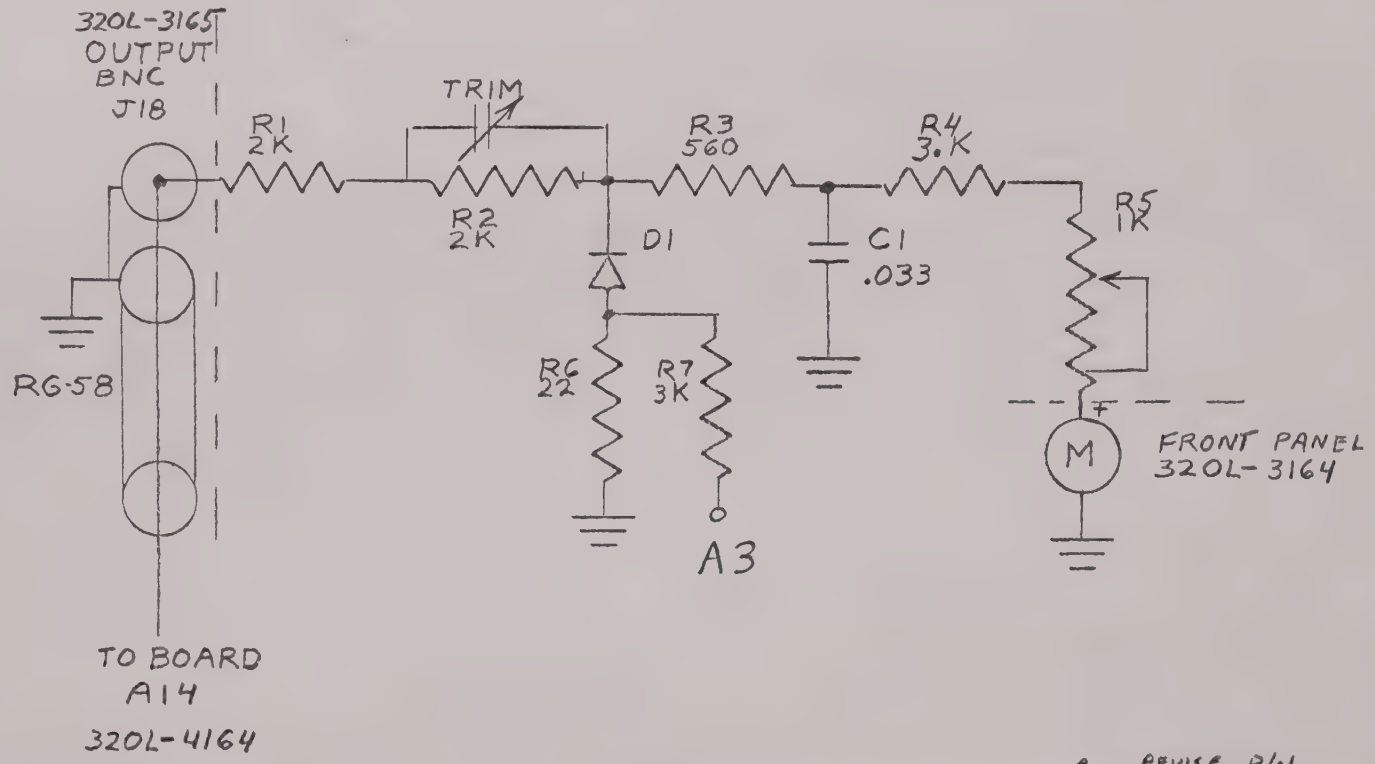


HIGHEST NO.
R7
C1
D1

A REVISE P/N 12-72

ELECTRONIC NAVIGATION IND.

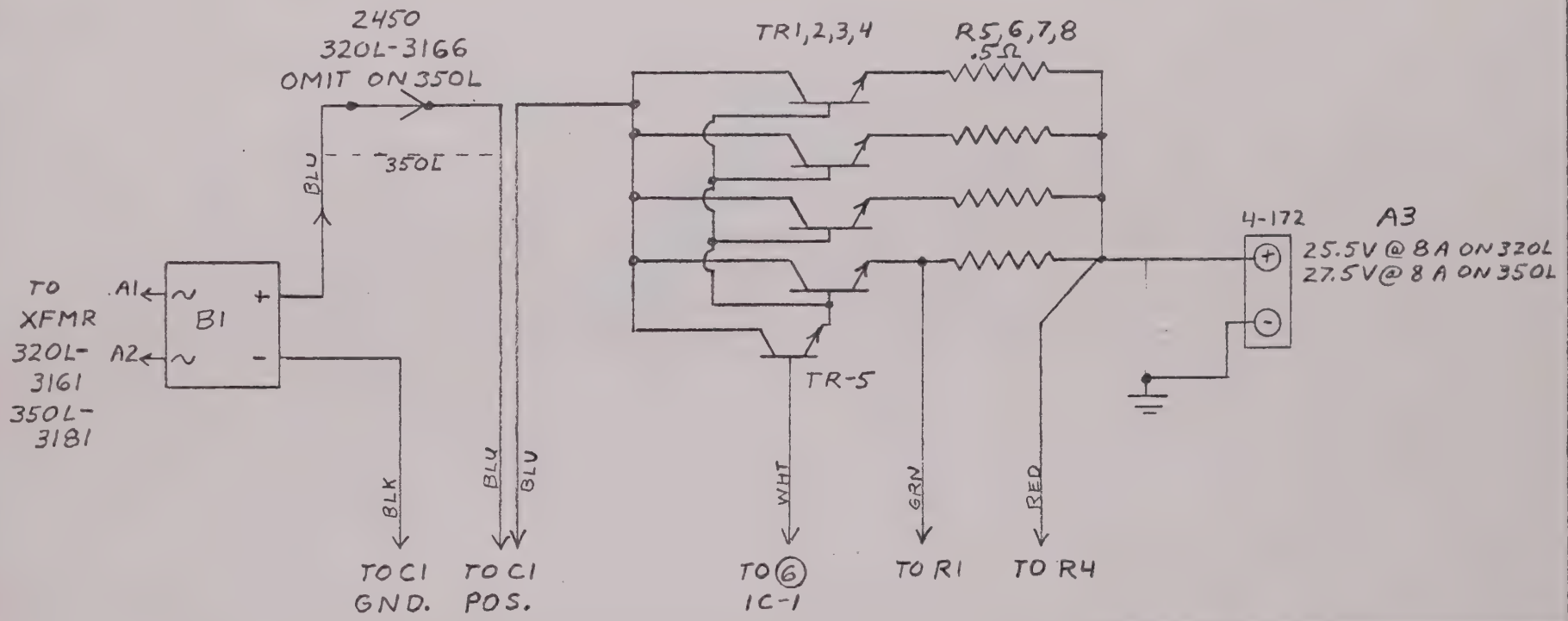
MODEL 320L	SCALE	DRAWN BY FBW
		REVISED

TITLE
RF VOLTMETER BOARD, A12

DATE	APPROVED BY	DRAWING NUMBER
17 Oct 70	TC	320L-4162

K+E ALBANENE ® 10 5455
ARCHITECTS' STANDARD FORM

MADE IN U. S. A.
28731



320L-4163
350L-4183

LTR	REVISIONS	DATE
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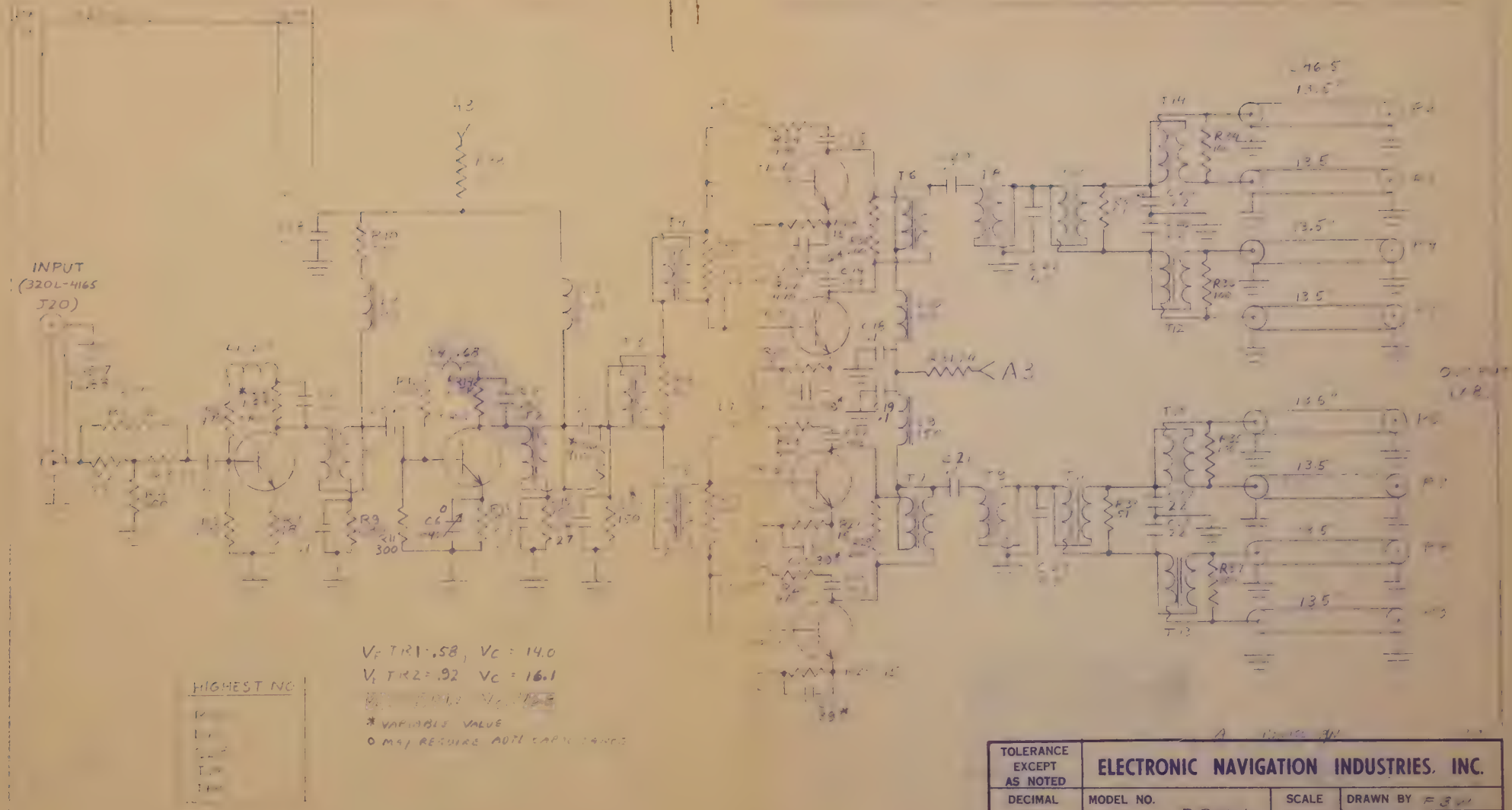
			APPROVED BY
FRACTIONAL	DESCRIPTION POWER SUPPLY		
ANGULAR	DATE DEC. 72	DRAWING NUMBER 320L-3162	



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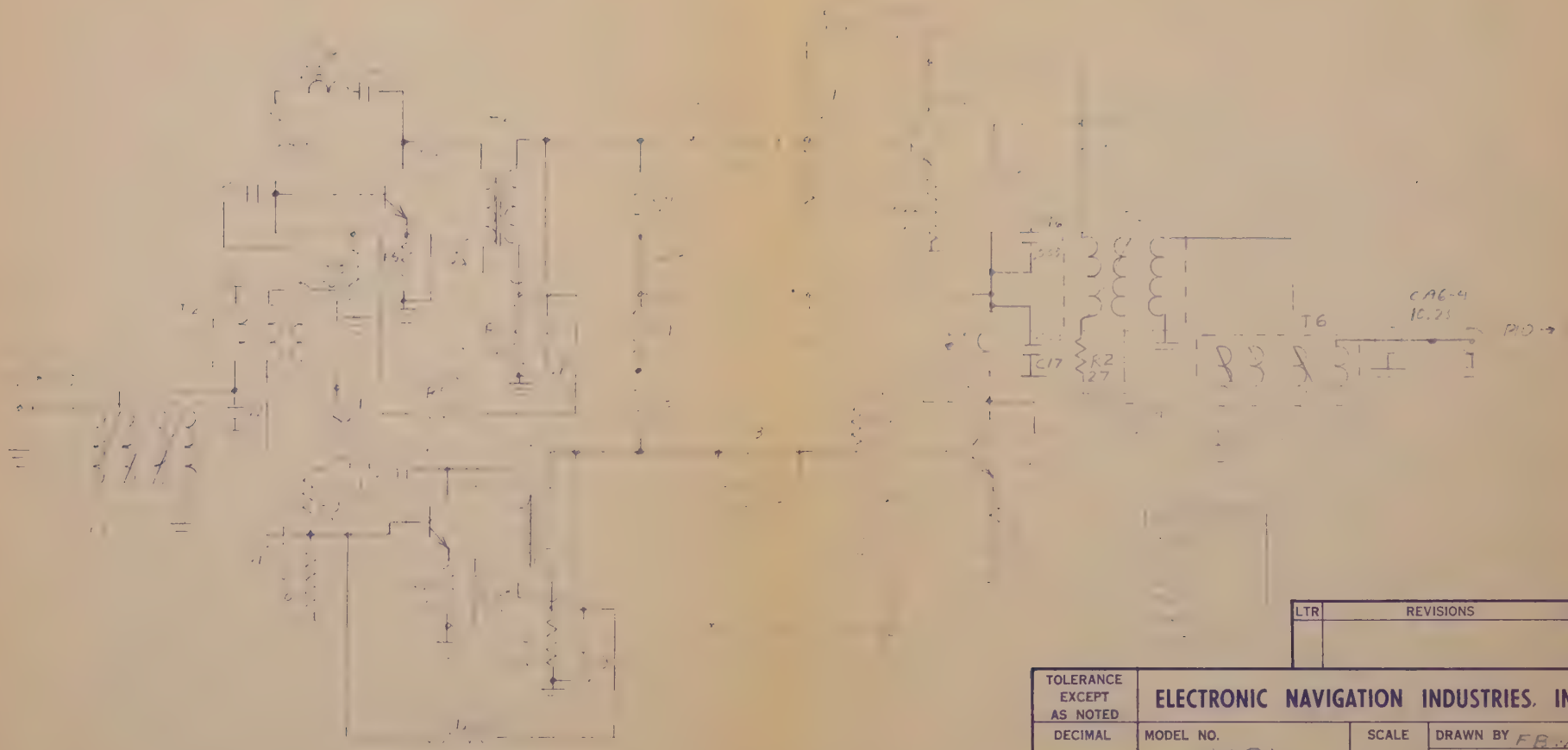
ANGULAR —	DATE OCT 70	DRAWING NUMBER 320L-4165	



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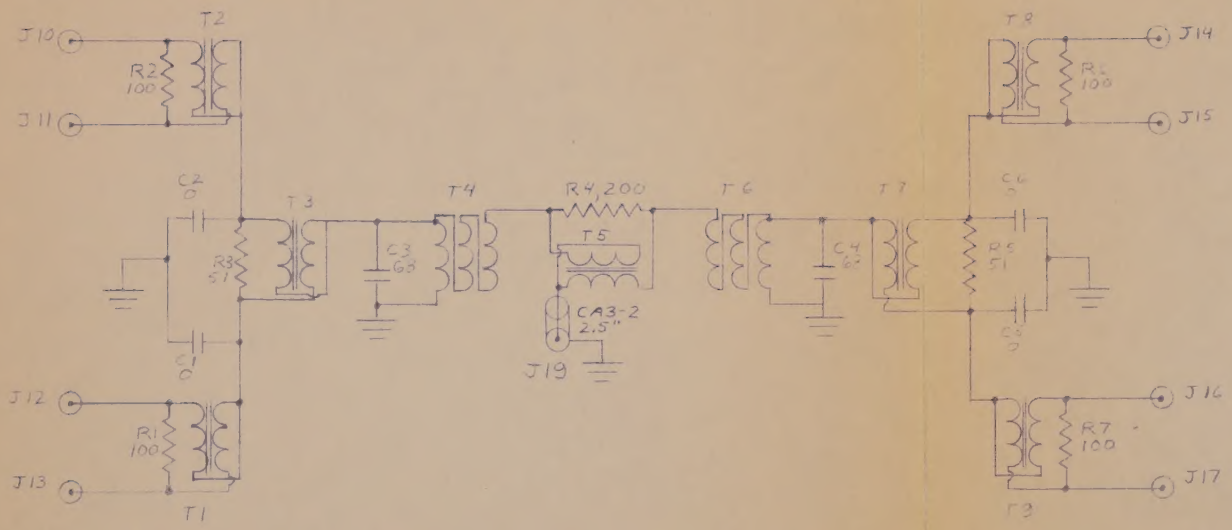

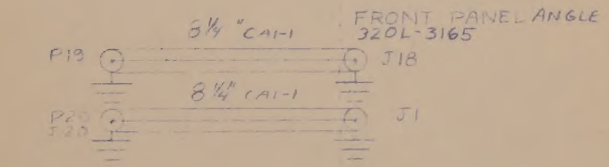

LTR	REVISIONS	DATE
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